Mapping Community-Relevant Critical Infrastructure in Ramsey County

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RAMSEY COUNTY

Resilient Communities Project
University of Minnesota
Building community-university partnerships for sustainability

The project on which this report is based was completed in collaboration with Ramsey County as part of the 2018–2019 Resilient Communities Project (RCP) partnership. RCP is a program at the University of Minnesota's Center for Urban and Regional Affairs (CURA) that connects University faculty and students with Minnesota communities to address strategic projects that advance local resilience and sustainability.

The contents of this report represent the views of the authors, and do not necessarily reflect those of RCP, CURA, the Regents of the University of Minnesota, or Ramsey County.

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Resilient Communities Project
University of Minnesota
Building Community-University Partnerships for Resilience

Project Report: Mapping Community-Relevant Critical Infrastructure in Ramsey County

INTRODUCTION

Ramsey County is the most densely populated and racially diverse county in Minnesota. Ramsey County embraces a unique urban and suburban blend of cultures, activities, sports, Fortune-500 companies, and natural resources (SPRCPH, 2013). Social vulnerability arises from inequality, which in turn affects access to resources and information. (Cutter et al., 2008). Ramsey County is susceptible to winter storms, flooding, prolonged power outages, and other natural disasters, so proper infrastructure can significantly reduce the number of resident casualties when disasters occur.

The project seeks to analyze Ramsey County with the most reasonable facilities/shelters to assist its communities in the event of disasters and emergencies. At the same time, we make a superposition analysis of the population that the alternative infrastructure can hold. We have spatially analyzed the number of shelters in each block group to intuitively see which block group infrastructure is in urgent need of improvement, and to provide a reference basis for subsequent infrastructure development in Ramsey County. The focus of this project was to formulate the criteria for selecting urgent infrastructure.

We will thoroughly explain this project with the data, the methodology and implementation, results, further development, and conclusion.

OBJECTIVES

We posed several questions in the process of this research:

- How do we define the facilities/community centers within Ramsey County? Which fields and land use types in the parcel data could be used to determine potential as a gathering place?
- How do we judge the accessibility of these facilities for residents? Do we combine them with demographic data, or evaluate accessibility based on total number and available space?
- Do Ramsey County's existing community center options reasonably cover most of its residents?

IMPLEMENTATION

Dataset

In this project, we selected parcels under certain land use fields, then judged the accessibility of these facilities in the block group level in Ramsey County. We then made choropleth maps based on this analysis. We used many data layers from a multitude of sources, all of which are listed below.

Parcel Data: http://openramsey-ramseygis.opendata.arcgis.com/datasets/3115ff6090374657966045568434 20be_33

Block group data (base map): https://www.census.gov/geo/maps-data/data/cbf/cbf_blkgrp.html

Total population of each block group: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

Neighborhood: https://gisdata.mn.gov/dataset/us-mn-co-ramsey-bdry-admin-boundary-data

Street data: http://openramsey-ramseygis.opendata.arcgis.com/datasets/4bfdf4fc137f47159155ad6681a8c595_44

Methodology

We defined the projection and extracted the data within Ramsey County. Seen below are the parameters of spatial reference in this project:

Projected Coordinate System:	NAD_1983_UTM_Zone_15N
Projection:	Transverse_Mercator
False_Easting:	500000.00000000
False_Northing:	0.00000000
Central_Meridian:	-93.00000000
Scale_Factor:	0.99960000
Latitude_Of_Origin:	0.00000000
Linear Unit:	Meter

Geographic Coordinate System:	GCS_North_American_1983
Datum:	D_North_American_1983
Prime Meridian:	Greenwich
Angular Unit:	Degree

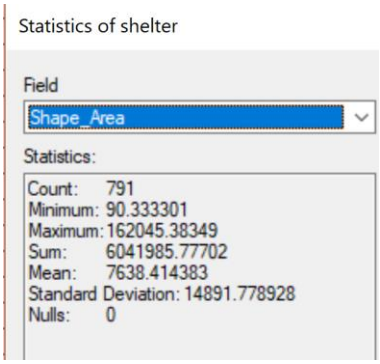
The parcel data was initially filtered through the 'use type' field, which describes the broad category of land use types for each parcel. It is then filtered again through the 'land use description' field, which represents precisely for what each parcel is used. The parcels were filtered according to our previous research on acceptable community gathering locations. Shown below are the land use types we selected for the shelters:

Use type:	**Land use description:**
Charity Inst	Community shopping center
Church	Convenience store
Comm Services	Daycare center
Commercial	Discount store & Department store
ER Shelter	Exempt library
Hospital	Exempt charity facility
School	Commercial center
Trans Housing	Gas station
Sr Citizens Fac	Medical clinic
	Neighborhood/Regional shopping center
	Restaurant & bar
	Supermarket

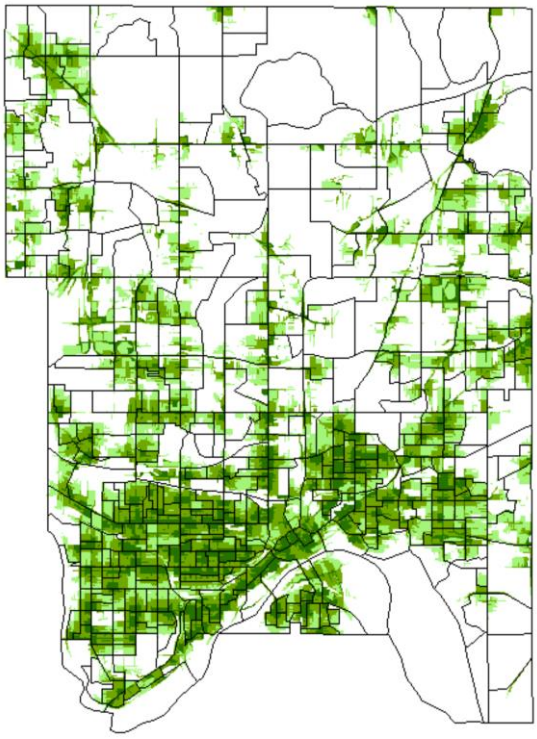
Note: It is worth mentioning that future studies could apply similar methods and modify the selection of "Use Type" and "Land Use Description" according to the specific requirements of the analysis being undertaken.

Finally, we filtered the selection by area, as some parcel types meet the land use type requirements, but the area is too small for emergency relief in the event of a disaster. In the "Design of FEMA Guidance for Shelters and Safe Rooms" file, they suggest that each shelter should be able to accommodate at least 12 people. If an occupancy duration of less than 24 hours does not require sleeping areas, the occupant load will generally be a net 1.86 m^2/person (20 square feet/person). If an occupancy duration greater than 24 hours requires sleeping areas, the minimum floor area, with the use of single size beds, is approximately 5.6 m^2/person (60 square feet/person). With the use of bunk beds, the minimum floor area is approximately 2.8 m^2/person (30 square feet/person). Because the area is freezing cold for almost half of

every year and extra space is necessary for heating, we chose 60 square feet/person as the criterion. The minimum parcel area in this project is 90m^2 (see the picture below), satisfying the above requirements. After we finished formulating the selection criteria, we converted the parcel data to points for further analysis.

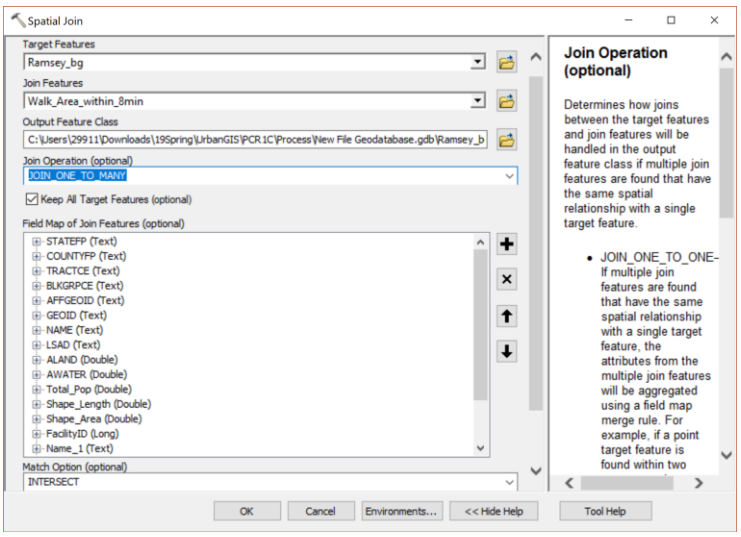


We believe that walking is the preferred mode of transportation during disasters. Therefore, we used the network analyst tool to calculate the service area of each shelter that can be reached within four minutes, eight minutes, and 12 minutes by walking at a normal pace (3.1 mph). Shown below are the results of this network analysis:



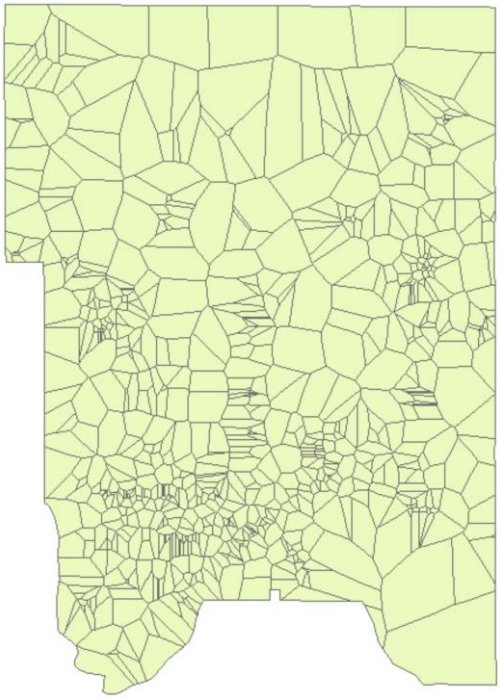
Then, we used the "spatial join" tool to summarize the number of facilities that can be reached within four minutes, eight minutes, and 12 minutes of each block group to judge the accessibility of the block group. The details of this spatial join are shown below. Open the attribute table of the output feature class, and two fields are automatically generated: Join_Count and TARGET_FID. Join_Count represents the

number of facilities that can be reached within four, eight, and 12 minutes of each district. We later used this field to create the choropleth map.



Shape *	Join_Count	TARGET_FID
Polygon	19	1
Polygon	26	2
Polygon	7	3
Polygon	7	4
Polygon	15	5
Polygon	14	6
Polygon	10	7
Polygon	15	8
Polygon	6	9
Polygon	18	10
Polygon	12	11
Polygon	27	12
Polygon	22	13
Polygon	4	14
Polygon	11	15
Polygon	40	16
Polygon	30	17
Polygon	2	18
Polygon	12	19
Polygon	25	20

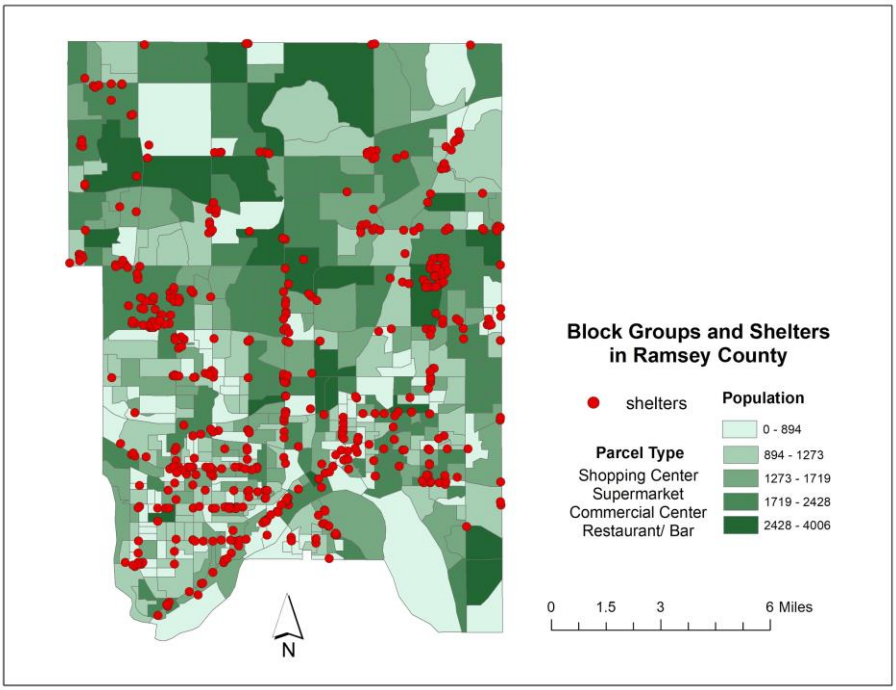
Another way we evaluated the accessibility of facilities in Ramsey County was to combine their data layer with demographic data to figure out how many people each shelter could serve. We created a Thiessen polygon layer from the shelter point layer to see the area closest to each facility, then intersected it with the block group data to determine the percentage of space that shelter's Thiessen polygon covers in each block group. Then, we multiplied the total population of each block group by this percentage to get the number of people each shelter can serve. To get the entire served community, we used the dissolve tool to merge the intersected polygons belonging to the same block group by the fields 'ID2' and 'SUM'. The figure below shows the Thiessen polygon layer and the attribute table of the result. We later used 'SUM_Pop_Per' field for the visualization.

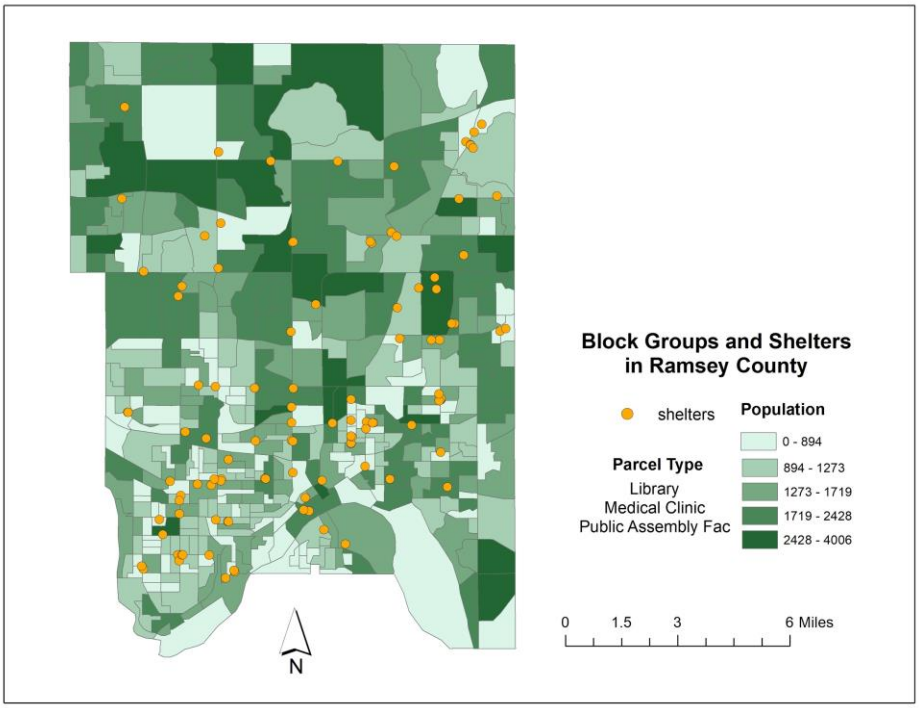


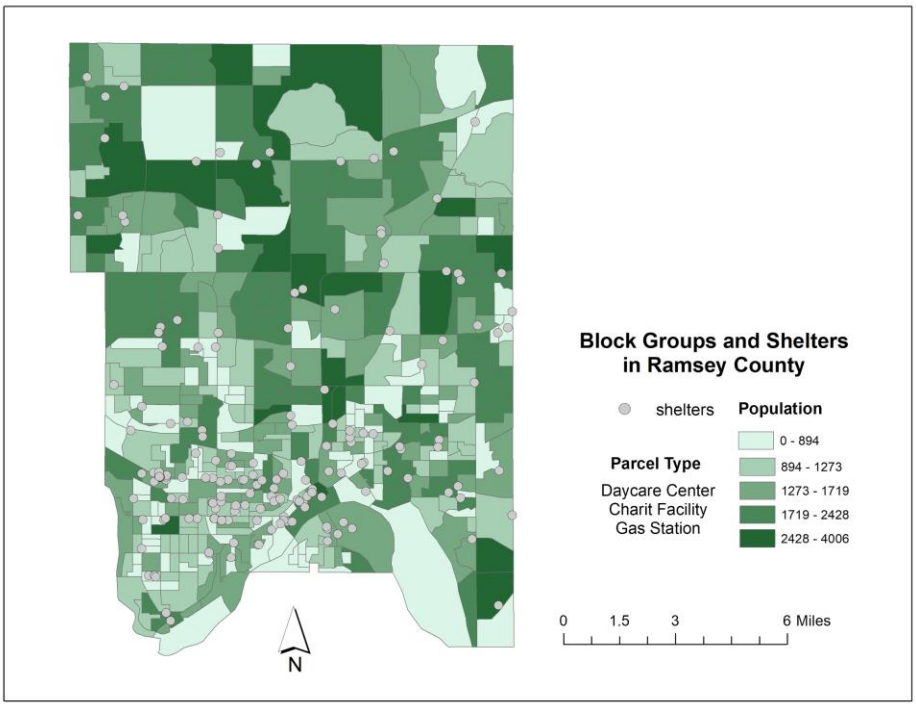
ParcelID	SUM_Pop_Per
012822140105	268.997208
012822140106	3.924383
012822410014	406.487661
012823120081	152.461651
012823120224	1088.125749
012823120287	251.487389
012823210045	305.141767
012823210271	753.763325
012823210448	84.914731
012823220067	428.106396
012823230042	503.631098
012823230085	464.568475
012823240123	437.416926
012823240221	519.54853
012823320265	1305.102826
012823340168	87.810621
012823340227	57.537273
012823340229	349.69226
012823410062	92.105724
012823410140	11.644709
012823410162	255.967642
012823410167	56.337291

Visualization

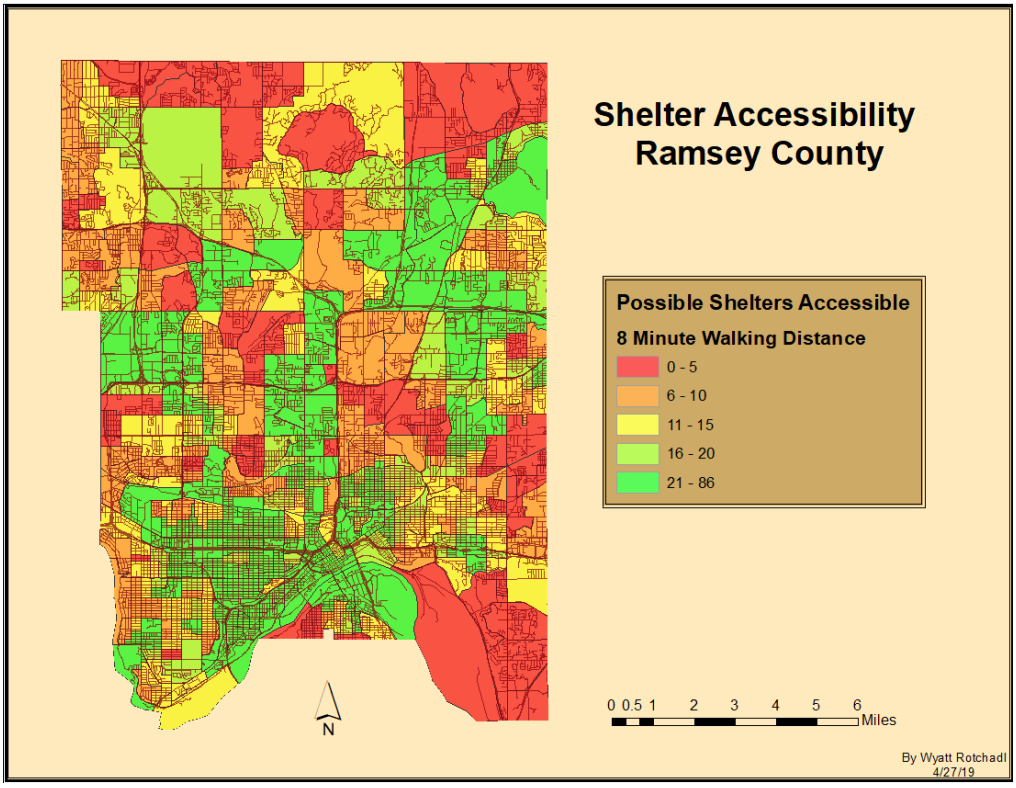
In this project, the parcels we selected were too dense, so we divided them into three categories according to their land use types in the visualization process: Commercial Use, Public Use, and Other. We then made three maps to show the location of each shelter type. The following three maps show the locations of these three shelters types:







The next map shows the count of facilities within about a half-mile walk from each block group:



RESULT

After combining the Network Analysis with the shelter data, we were able to determine which areas in Ramsey County are lacking in regards to shelter accessibility. The downtown areas of St. Paul have quite good accessibility to shelters within a half mile walk. Parts of Falcon Heights and Little Canada have sizable populations, but have limited access to possible shelter locations. Accessibility is lacking again in Northern Ramsey County. Much of this is due to lower population density and the natural features, however better accessibility should still be attempted here. Areas near major arterial roads have greater access to possible shelters. Areas near the fringes of the county generally have poorer access to possible shelter locations.

The analysis we have done can be used by the county to determine what facilities should be used, and where they should be located in order to better determine how the county should provide disaster relief to all of its residents.

CONCLUSION

For further development, we can combine our analysis with other data concerning the vulnerability of communities. We can also make a superposition analysis of the vulnerable population in Ramsey County and the population that its critical infrastructure can hold in order to see whether the shelters in each block group can satisfy the needs.

Another thing we can do is narrow down acceptable community gathering locations. In this project, we only choose facilities according to the land use type, as we were unable to integrate with specific situational data such as the preference of the residents in the community. We can gather this situational data by surveying residents within Ramsey County.

REFERENCES/ RELATED RESOURCES

Cutter, A. (2008). Global Environmental Change: A place-based model for understanding community resilience to natural disasters. October 2008, Pages 598-606

Risk Management Series: Design Guidance for Shelters and Safe Rooms
https://www.fema.gov/pdf/plan/prevent/rms/453/fema453.pdf

Saint Paul - Ramsey County Public Health (SPRCPH). 2013. *Health status & trends of our community: Ramsey County Community Health Assessment*.
https://www.ramseycounty.us/sites/default/files/Open%20Government/Public%20Health%20Data/community_health_assessment_030515.pdf